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Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Frequency Division Multiple Access (FDMA) point to multipoint DRRS in the band 3 GHz to 11 GHz

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

The present document contains the minimum technical requirements to ensure compatibility of products and conformance with radio regulations across ETSI member states. Radio terminals from different manufacturers are not required to inter work at radio frequency (i.e. no common air interface).

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
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Introduction

The main field of application of Point-to-Multipoint (P-MP) systems, using the Fixed Service (FS), is to provide access to both public and private networks (Public Switched Telephone Network (PSTN), Public Data Network (PDN), etc.). By means of P-MP systems the network service area may cover scattered subscriber locations. The systems may be applied to build new access networks by means of a multi cellular architecture, covering both urban and regional areas.

Subscribers are offered the full range of services by the particular public or private network. Subscribers have access to these services by means of the various standardized user network interfaces (e.g. 2-wire loop, and Integrated Services Digital Network (ISDN) ranging from basic rate to n × primary rate).

P-MP systems provide standard network interfaces and transparently connect subscribers to the appropriate network node. These systems allow a service to be connected to a number of subscribers ranging from a few to several thousand, and over a wide range of distances.

P-MP systems are generally configured as pre-assigned systems or as Demand Assigned Multiple Access (DAMA) radio systems.

The essential features of a typical P-MP radio system are:

- efficient use of the radio spectrum;
- concentration;
- transparency.

Radio is often the ideal way of obtaining communications at low cost and almost independent of distance, and difficult topography. Moreover, a small number of sites are required for these installations, thus facilitating rapid implementation and minimizing maintenance requirements of the systems.

Concentration means that *m* subscribers can share *n* radio channels (*m* being larger than *n*), allowing a better use of the available frequency spectrum at a lower equipment costs. The term "multi-access" means that every subscriber has access to every channel (instead of a fixed assignment as in most multiplex systems). When a call is initiated, an available channel is allocated to it. When the call is terminated, the channel is released for another call.

Concentration requires the use of distributed intelligent control which in turn allows many other operation and maintenance functions to be added.

Transparency means that the network node (service node) and the subscriber equipment communicates with each other without being aware of the radio link.

1 Scope

The present document specifies the minimum requirements for system parameters of Frequency Division Multiple Access (FDMA) Point-to-Multipoint (P-MP) radio systems in the terrestrial Fixed Service (FS) operating in the bands 3 GHz to 11 GHz.

The system will provide access to both public and private networks (Public Switched Telephone Network (PSTN), Public Data Network (PDN), etc.) by means of the various standardized network interfaces (e.g. 2-wire loop, Integrated Services Digital Network (ISDN) and 2 Mbit/s).

The system may be applied to build access networks by means of a multi cellular architecture, covering urban, including suburban, and regional areas.

The FDMA P-MP system will transmit a Radio Frequency (RF) signal from the customer site to the Central Station (CS) only utilizing a spectral bandwidth corresponding to that capacity which is requested from and assigned to the customer by pre-assignment or by Demand Assigned Multiple Access (DAMA). The CS receives from each customer site a single modulated carrier being processed independently within the CS. Thus the CS is receiving a FDMA signal.

The present document covers the following typical P-MP applications:

The transmission of:

- voice;
- fax;
- voice band data;
- telex;

related to analogue interfaces and:

- 64 Kbit/s;
- ISDN;
- digital video;
- digital audio;

related to digital interfaces.

Further applications like Asynchronous Transport Mode (ATM) may also be provided.

Two classes of systems have been defined in order to take into account the large variety of possible applications due to access network implementations and type of service to be provided.

The equipment covered by the present document should be designed to be able to meet the network performance requirements foreseen by ITU-R Recommendations F.696 [1] and F.697 [2], for medium, local grade or ITU-R Recommendation F.1189 [3] national portion (access or short haul) of the digital connection following the criteria defined in ITU-T Recommendation(s) G.821 [4] and/or G.826 [5]. It should be noted that the values for B and C are provisional taking also into account note 5 of ITU-R Recommendation F.1189 [3].

The availability requirements are under further study by the relevant bodies.

Network operators may choose different performance and availability requirements in order to extend the possible area of application thus fitting to their network needs.

Radio terminals from different manufacturers are not intended to interwork at radio frequency (i.e. no common air interface).

The present document defines the requirements of radio terminal and radio-relay equipment including the interfaces. The requirements for multiplex, network management and antenna/feeder equipment may be addressed elsewhere.

2 Normative references

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ITU-R Recommendation F.696: "Error performance and availability objectives for hypothetical reference digital sections forming part or all of the medium-grade portion of an ISDN connection at a bit rate below the primary rate utilizing digital radio relay systems".

[2] ITU-R Recommendation F.697: "Error performance and availability objectives for the local grade portion at each end of an ISDN connection a bit rate below the primary rate utilizing digital radio relay systems".

[3] ITU-R Recommendation F.1189: "Error-Performance Objectives for constant bit rate digital paths at or above the primary rate carried by digital radio-relay systems which may form part or all the national portion of a 27500 km hypothetical reference path".

[4] ITU-T Recommendation G.821: "Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network".

[5] ITU-T Recommendation G.826: "Error performance parameters and objectives for international constant bit rate digital paths at or above the primary rate".

[6] ERC Recommendation 14-03: "Harmonised radio frequency channel arrangements for low and medium capacity systems in the band 3 400 MHz to 3 600 MHz".

[7] ERC Recommendation 12-05: "Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.0 - 10.68 GHz".

[8] ETS 300 019: "Equipment engineering (EE); Environmental conditions and environmental tests for telecommunication equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations and Part 1-4: Classification of environmental conditions Stationary use at non-weatherprotected locations".

[9] ETS 300 132: "Equipment engineering; Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources and Part 2: Operated by direct current (dc)".

[10] ETS 300 385: "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for digital fixed radio links and ancillary equipment with data rates at around 2 Mbit/s and above".

[11] ETS 300 339: "Radio Equipment and Systems (RES); General electromagnetic compatibility (EMC) for radio communications equipment".

[12] ITU-T Recommendation G.773: "Protocol suites for Q-interfaces for management of transmission systems".

[13] ITU-T Recommendation G.810: "Definitions and terminology for synchronisation networks".

[14] ITU-T Recommendation G.812: "Timing requirements at the output of slave clocks suitable for plesiochronous operation of international digital links".

[15] ITU-T Recommendation G.823: "The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy".

[16] ITU-T Recommendation G.813: "Timing characteristics of SDH equipment slave clocks (SEC)".

[17] ITU-T Recommendation G.825: "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy".

[18] prETS 300 833: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Antennas used in point-to-point DRRS operating in the frequency band 3 to 60 GHz".

[19] DE/TM-04049: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Antennas for use in point to multipoint DRRS in the 3 GHz to 11 GHz band".

[20] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".

[21] ITU-T Recommendation G.131: "Stability and echo".

[22] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".

[23] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s adaptive differential pulse code modulation (ADPCM)".

[24] ITU-T Recommendation G.728: "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".

[25] ITU-T Recommendation G.729: "Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction".

[26] ITU-T Recommendation O.151: "Error performance measuring equipment operating at the primary rate and above".

[27] ITU-T Recommendation O.181: "Equipment to assess error performance on STM-N interfaces".

[28] ITU-R Recommendation SM.329: "Spurious Emissions".

[29] DE/TM-04040: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Generic standard on unwanted emissions and receiver immunity at antenna ports of DRRS".

[30] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".

[31] ITU-T Recommendation Q.553: "Transmission characteristics at 4-wire analogue interfaces of digital exchanges".

[32] ITU-T Recommendation R.20: "Telegraph modem for subscriber lines".

[33] ITU-T Recommendation V.-series: "Data communication over the telephone network".

[34] ITU-T Recommendation X.-series: "Data networks and open system communication".

[35] ITU-T Recommendation G.961: "Digital transmission system on metallic local lines for the ISDN basic rate access".

[36] ETS 300 012: "Integrated Services Digital Network (ISDN); Basic user-network interface Layer 1 specification and test principles".

[37] ETS 300 011: "Integrated Services Digital Network (ISDN); Primary rate user-network interface; Layer 1 specification and test principles".

[38] ITU-T Recommendation G.962: "Access digital line section for ISDN primary rate at 2048 kbit/s".

[39] ITU-T Recommendation G.707: "Network node interface for the synchronous digital hierarchy".

[40] ITU-T Recommendation G.964: "V-Interfaces at the digital local exchange (LE) - V5.1-interface (based on 2048 kbit/s) for the support of access network (AN)".

[41] ITU-T Recommendation G. 965: "V-Interfaces at the digital local exchange (LE) - V5.2-interface (based on 2048 kbit/s) for the support of access network (AN)".

[42] ITU-T Recommendation G.957: "Optical interfaces for equipment and systems relating to synchronous digital hierarchy".

[43] ETS 300 324: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE) V5.1 interface for the support of Access Network (AN)".

[44] ETS 300 347: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE) V5.2 interface for the support of Access Network (AN)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

Full Capacity Load (FCL): the maximum number of 64 kbit/s signals or the equivalent which can be transmitted and received by a single Central Radio Station (CRS) within a specified RF bandwidth, fulfilling a given performance and availability objectives in respect to fading conditions.

round trip delay: the sum of the delay between point A to B plus B to A in figure 1 including any repeaters as appropriate.

nominal output power: the maximum output power of the CRS, Terminal Station (TS) or Repeater Station (RS) referred to point C' (figure 2) under Full Load Condition (FLC), as declared by the manufacturer.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

dB	decibel
dBm	decibel relative to 1 mW
GHz	GigaHertz
km	kilometre
Mbit/s	Megabit per second
MHz	MegaHertz
ns	nanosecond
ppm	parts per million

3.3 Abbreviations

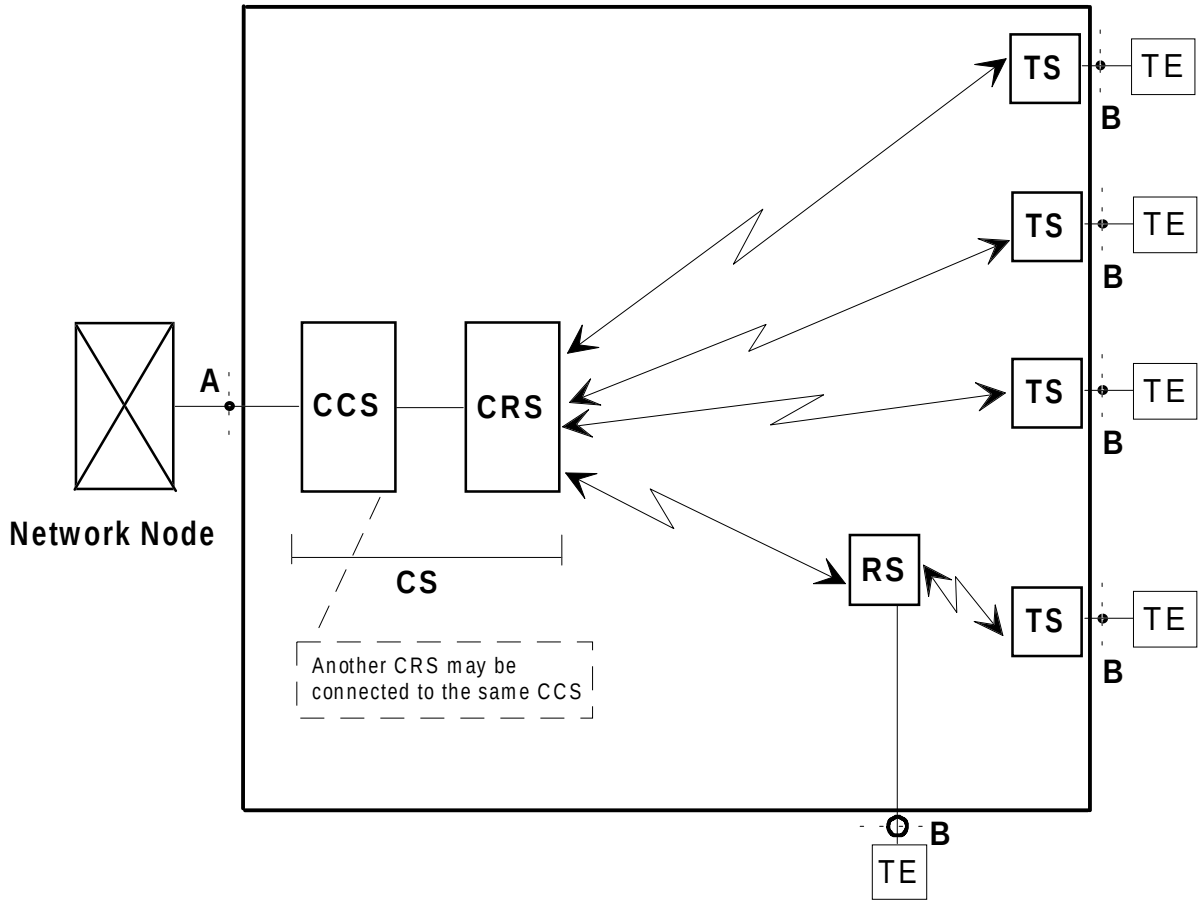
For the purposes of the present document, the following abbreviations apply:

ATM	Asynchronous Transport Mode
ATPC	Automatic Transmit Power Control
BB	Base Band
BBER	Background BER
BER	Bit Error Ratio
CCS	Central Controller Station
CEPT	Conférence des Administrations Européennes des Postes et Télécommunications
CRS	Central Radio Station
CS	Central Station

CW	Continuous Wave
DAMA	Demand Assigned Multiple Access
EMC	Electromagnetic Compatibility
ERC	European Radiocommunications Committee
FCL	Full Capacity Load
FDMA	Frequency Division Multiple Access
FLC	Full Load Condition
FS	Fixed Service
IF	Intermediate Frequency
IF/RF	Intermediate Frequency/Radio Frequency
ISDN	Integrated Services Digital Network
LO	Local Oscillator
NFD	Net Filter Discrimination
NNI	Network Node Interface
PDH	Plesiochronous Digital Hierarchy
PDN	Public Data Network
P-MP	Point to Multipoint
PP	Point to Point radio relay system
PRBS	Pseudo-Random Binary Sequence
PSTN	Public Switched Telephone Network
RF	Radio Frequency
RS	Repeater Station
RSDL	Receive Spectral Density Level
RSL	Receiver input Signal Level
Rx	Receiver
SDH	Synchronous Digital Hierarchy
SRL	Spectrum Reference Level
STM-1	Synchronous Transport Module level 1
Sub-STM-1	Customary wording for RR-STM (Synchronous Transport Module)
TE	Terminal Equipment
TMN	Telecommunications Management Network
TS	Terminal Station
Tx	Transmitter

4 General characteristics

4.1 General system architecture



CS: Central Station which can be subdivided into two units:

CCS: Central Controller Station which provides the interface to the local switch; and

CRS: Central Radio Station which is the central base station containing at least the radio transceiver equipment providing the interface to the Terminal Station via the air.

A CRS may be equipped with more than one transceiver. Each transceiver is connected to a separate antenna. This is used e.g. if sectored cells are applied to increase the capacity of each cell.

TS: Terminal Station which provides interfaces to the subscriber equipment.

RS: Repeater Station which may also provide interfaces to the subscriber equipment.

TE: Terminal Equipment.

NOTE 1: CCS may control more than one CRS.

NOTE 2: A TS may serve more than one TE.

Figure 1: General system architecture

The CS performs the interconnection with the local switching exchange (service node) carrying out a concentration function by sharing the total number of available channels in the system. The CS is linked either directly to all TSs or via a RS by microwave transmission paths.

Whenever an existing digital transmission link is available, the network implementation can be optimized by separating the CCS installed at the network node site and the CRS.

4.2 Frequency bands and channel arrangements

4.2.1 Channel plan

Table 1 gives details of those frequency bands in the range 3 GHz to 11 GHz which have been identified by CEPT/ERC for P-MP applications. The present document is also applicable for additional bands within the frequency range 3 GHz to 11 GHz which may be made available for P-MP application by CEPT/ERC (and ITU-R) in the future.

Table 1: Frequency bands

Frequency band (GHz)	Band limits (GHz)	Recommendation	Transmit/receive spacing (MHz)	Channel spacing (MHz)
3,5	3,4 to 3,6	ERC Recommendation T/R 14-03 [6]	50/100	0,5 (slots)
10,5	10,15 to 10,3 paired with 10,50 to 10,65	ERC Recommendation T/R 12-05 [7]	350	0,5 (slots)

4.2.2 Proposed channel arrangements

The system shall meet at least one of the channel arrangements listed in table 2.

Table 2: Channel arrangement

Channel spacing (MHz)	1	1,75	2	3,5	7	14	28	30
Minimum CRS transmission capacity (kbit/s) 4 state modulation (or equivalent) (see note 1)	12 × 64	21 × 64	24 × 64	42 × 64	84 × 64; 4 × 2 048	8 × 2 048	16 × 2 048	17 × 2 048
Minimum CRS transmission capacity (Kbit/s) 8 state modulation (or equivalent) (see note 1)	18 × 64	31 × 64	36 × 64	62 × 64	5 × 2048	10 × 2 048	20 × 2 048	22 × 2 048
Minimum CRS transmission capacity (Kbit/s) 16 state modulation (or equivalent) (see note 1)	24 × 64	42 × 64	48 × 64	84 × 64; 4 × 2 048	8 × 2048	16 × 2 048	32 × 2 048	34 × 2 048

NOTE 1: "or equivalent" means: providing the same capacity regardless of the actual modulation scheme.

NOTE 2: Allocated RF channels may be occupied by systems using smaller RF-channel spacing as long as the spectrum mask for the allocated RF channel is not exceeded.

NOTE 3: Any other equivalent transmission capacity may be transported, e.g. instead of 42 × 64 Kbit/s a capacity of 21 × 128 Kbit/s can be transmitted.

4.3 Compatibility requirements

There is no requirement to operate the CRS from one manufacturer with the TS and RS from another manufacturer.

4.4 Environmental conditions

The equipment shall be required to meet the environmental conditions set out in ETS 300 019 [8] which defines weather protected and non-weather protected locations, classes and test severity.

The manufacturer shall state which class the equipment is designed to withstand.

4.4.1 Equipment within weather protected locations (indoor locations)

The equipment intended for operation within temperature controlled locations or partially temperature controlled locations shall meet the requirements of ETS 300 019 [8] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [8] classes 3.3 (non-temperature controlled locations), 3.4 (sites with heat trap) and 3.5 (sheltered locations) may be applied.

4.4.2 Equipment for non-weather protected locations (outdoor locations)

Equipment intended for operation in non-weather protected locations shall meet the requirements of ETS 300 019 [8], class 4.1 or 4.1E.

Class 4.1 applies to many European countries and class 4.1E applies to all European countries.

For systems supplied within specific radio cabinets which gives full protection against precipitation, wind, etc. the ETS 300 019 [8] classes 3.3, 3.4 and 3.5 may be applied also for equipment intended for operation in non-weather protected locations.

4.5 Power supply

The power supply interface shall be in accordance with the characteristics of one or more of the secondary voltages foreseen in ETS 300 132, Parts 1 and 2 [9].

NOTE: Some applications may require a power supply that is not covered by ETS 300 132 [9].

4.6 Electromagnetic Compatibility (EMC) conditions

FS equipment with capacity of about 2 Mbit/s and above shall operate under the conditions specified in ETS 300 385 [10]. For lower capacities the subject is under study, however ETS 300 339 [11] shall apply on a provisional basis.

Two different locations, the CS location and the TS location, have to be considered with respect to the characteristics of severity parameters related to EMC.

4.7 Telecommunications Management Network (TMN) interfaces

TMN interfaces, if any, shall be in accordance with ITU-T Recommendation G.773 [12].

4.8 Synchronization of interface bit rates

Systems employing digital interfaces shall include methods enabling internal and external synchronization to the network. The principles for synchronization shall be met according to ITU-T Recommendation G.810 [13]. Tolerances shall be in accordance to ITU-T Recommendations G.812 [14] and G.823 [15] for systems providing Plesiochronous Digital Hierarchy (PDH) interfaces and/or ITU-T Recommendations G.813 [16] and G.825 [17] for systems providing Synchronous Digital Hierarchy (SDH) interfaces.

4.9 Branching/feeder/antenna requirements

4.9.1 Antenna radiation pattern

If high gain antennas (parabola antennas) are required for the TSs to cover longer hop lengths they shall comply with ETS 300 833 [18]. For other hop lengths the antennas for the TS shall comply with DE/TM 04049 [19].

Different types of antennas are envisaged for the CRS depending on the cell structure of the radio cell covered by the CS. Those antennas shall also comply with DE/TM 04049 [19].

5 System parameters

NOTE: If there is a reference made to the number of states of a modulation scheme, it is also permitted to apply an equivalent modulation scheme, if the system parameters are met.

5.1 System capacity

The system capacity considered in the present document is the transmission capacity of the CRS, which is the maximum payload bit rate (i.e. the maximum number of carriers transporting simultaneously their maximum payload bit rate each (according to ITU- Recommendation G.703 [20]) transmitted simultaneously over the air between a given CRS and its linked remote stations (TSs and/or RSs)).

The maximum number of simultaneous carriers which can be supported by the CRS shall be declared by the manufacturer.

5.2 Round trip delay

The round trip delay for a 64 kbit/s traffic channel shall not exceed 20 ms.

Longer round trip delays may result at other bit rates and when using speech coding at rates lower than 64 kbit/s.

In order to guarantee that the delay introduced by the system into the transmission network does not degrade the quality of the telephone communication, compliance to ITU-T Recommendation G.131 [21] shall be ensured.

5.3 Transparency

The system shall be fully transparent: the network node and the subscriber equipment (points A and B in figure 1) communicate with each other without being aware of the radio link.

5.4 Voice coding methods

One of the following coding methods should be used:

- 64 kbit/s ITU-T Recommendation G.711 [22];
- 32 kbit/s ITU-T Recommendation G.726 [23];
- 16 kbit/s ITU-T Recommendation G.728 [24];
- 8 kbit/s ITU-T Recommendation G.729 [25].

Other voice coding methods may be employed if the quality for voice transmission is adequate. The used coding method shall be declared by the manufacturer.

5.5 Transmitter characteristics

All transmitter characteristics are referred to a system under any load conditions.

The measurement shall be referred to point C' of figure 2.

Measurements shall be made when the CRS (at least one transceiver equipment) is under Full Load Conditions (FLC), to be declared by the manufacturer.

A Bit Error Rate (BER) lower than or equal to 10^{-6} shall be achieved at a receive level stated in subclause 5.7.2.

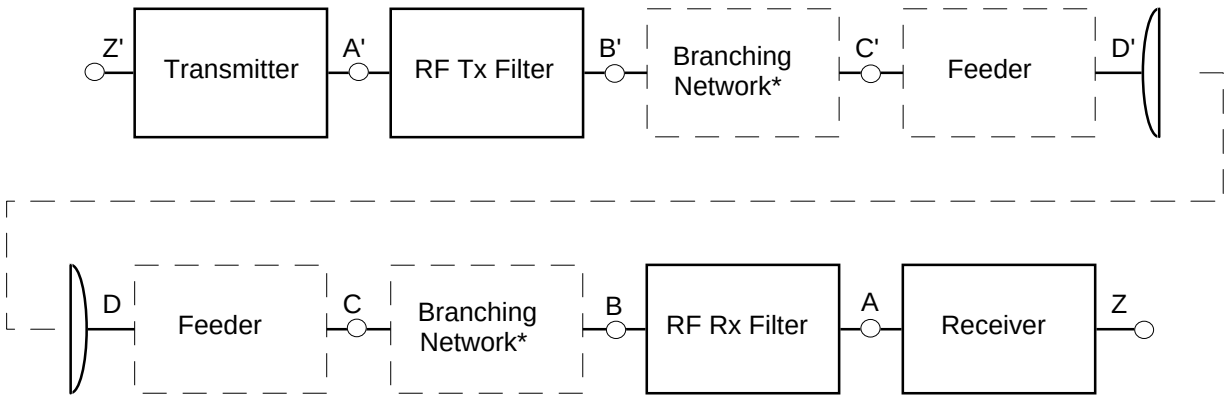
The specified transmitter characteristics shall be met with the appropriate input signals applied at point A or B of figure 1. For the PDH interface, this shall be in accordance with ITU-T Recommendation O.151 [26] and for SDH interfaces in accordance with ITU-T Recommendation O.181 [27].

5.5.1 Transmitter power range

The maximum mean output power of the transmitter for a CRS, TS and RS shall not exceed +35 dBm referenced to point C' of the RF system block diagram (see figure 2).

The manufacturer shall declare the nominal output power for the CRS, TS and RS under full load conditions.

The RF system block diagram figure 2 shows the point to point connection of the P-MP transceiver systems between the CRS and one TS (RS) and vice versa, as illustrated in figure 1.



NOTE: The points shown above are reference points only; points B, C and D, B', C' and D' may coincide.

Figure 2: RF system block diagram

A capability for output power level adjustment shall be provided by internal or external means.

5.5.2 Automatic Transmit Power Control (ATPC)

ATPC is considered to be an optional feature. Equipment with ATPC will be subject to manufacturer declaration of the ATPC ranges and related tolerances. Testing shall be carried out with output power level corresponding to:

- ATPC set manually to a fixed value for system performance;
- ATPC set at the nominal output power declared by the manufacturer.

5.5.3 Transmitter (Tx) Local Oscillator (LO) frequency arrangements

There is no requirement on LO frequency arrangement.

5.5.4 RF spectrum mask

5.5.4.1 RF spectrum mask for the central radio station

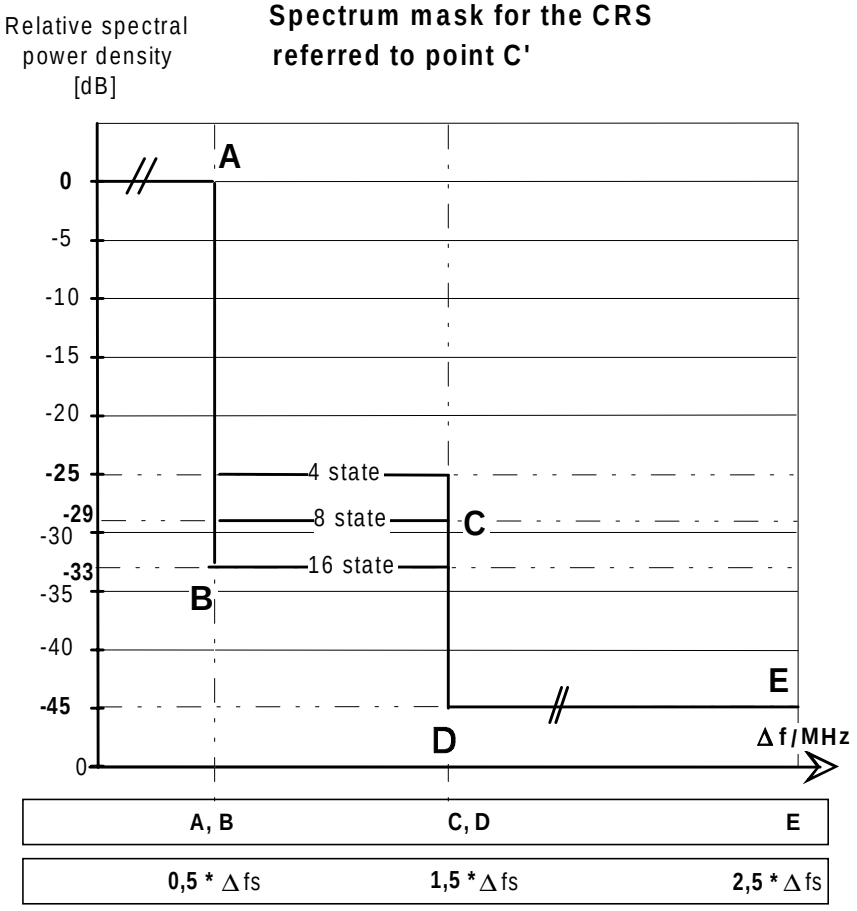
The 0 dB level shown on the spectrum masks is the maximum of the modulated spectrum disregarding residual carriers.

General test load conditions to measure the spectrum mask for the CRS transceiver:

- number (N) of carriers transmitted over one CRS transceiver should correspond with the FCL of the measured CRS. The number N shall be declared by the manufacturer;
- the output power for each carrier shall be 1/N of the nominal output power of the CRS referred to point C';
- the capacity of the CRS shall be equally distributed among the N single carriers.

NOTE: Under operational conditions the output power of some carriers may be greater than 1/N of the nominal output power.

The spectrum mask for the CRS transceiver is shown in figure 3.



NOTE 1: The different spectral power density levels for C are related to different modulation schemes.

NOTE 2: Frequency tolerances are not included in the mask.

Δ fs: RF-channel spacing (co-polar) between the centre frequencies of two adjacent CRS.

Figure 3: Spectrum mask for the CRS

The spectrum analyser settings for measuring the RF-spectrum mask are listed in table 3.

Table 3: Spectrum analyser settings for RF power spectrum measurement

RF channel spacing (MHz)	1	1,75	2	3,5	7	14	28, 30
Centre Frequency	actual	actual	actual	actual	actual	actual	actual
Sweep width (MHz)	10	10	20	20	40	80	160
Scan time	auto	auto	auto	auto	auto	auto	auto
IF bandwidth (kHz)	30	30	30	30	30	30	100
Video bandwidth	0,1	0,3	0,3	0,3	0,3	0,3	0,3

5.5.4.2 RF-spectrum mask for the terminal station and the repeater station

The RF-spectrum mask for the TS and the RS shall comply with the spectrum mask for the CRS transceiver.

5.5.5 RF tolerance

Maximum radio frequency tolerance shall not exceed ±10 ppm for the band 3 GHz to 11 GHz. Since this limit includes both short-term factors (environmental effects) and long-term ageing effects, the manufacturer shall state the guaranteed short-term part and the expected ageing part during the type test.

5.5.6 Spurious emissions

For the purpose of the present document, transmitter spurious emissions are defined as emissions at frequencies which are outside the nominal carrier frequency ±2,5 times the relevant channel spacing Δf_S as shown in figure 4. The limit values measured at point C' of figure 2 are shown in table 4.

Table 4: Transmitter spurious emissions allowed for CRS, RS and TS

From the edge of the defined spectrum mask ($F_0 \pm$ 250 % the relevant channel spacing Δf_S) to a frequency 56 MHz or ± 450 % the relevant channel spacing Δf_S whichever is less stringent.	Category A limits shall apply as specified by ITU-R SM. 329 [28] which is: -(43 dB + 10Log P) or -70 dBc below the mean power provided at reference point C' whichever is less stringent measured in 4 kHz bandwidth. P [W]
$30 < f < (5 \times F_0)$	-50 dBm (see note) for CRS and RS without TE interfaces
	-40 dBm (see note) for RS with TE interfaces and TS
NOTE: Spurious emissions to be measured in a 1 MHz resolution bandwidth for emissions above 1 GHz and in a 100 kHz resolution bandwidth for emissions falling between 30 MHz and 1 GHz.	

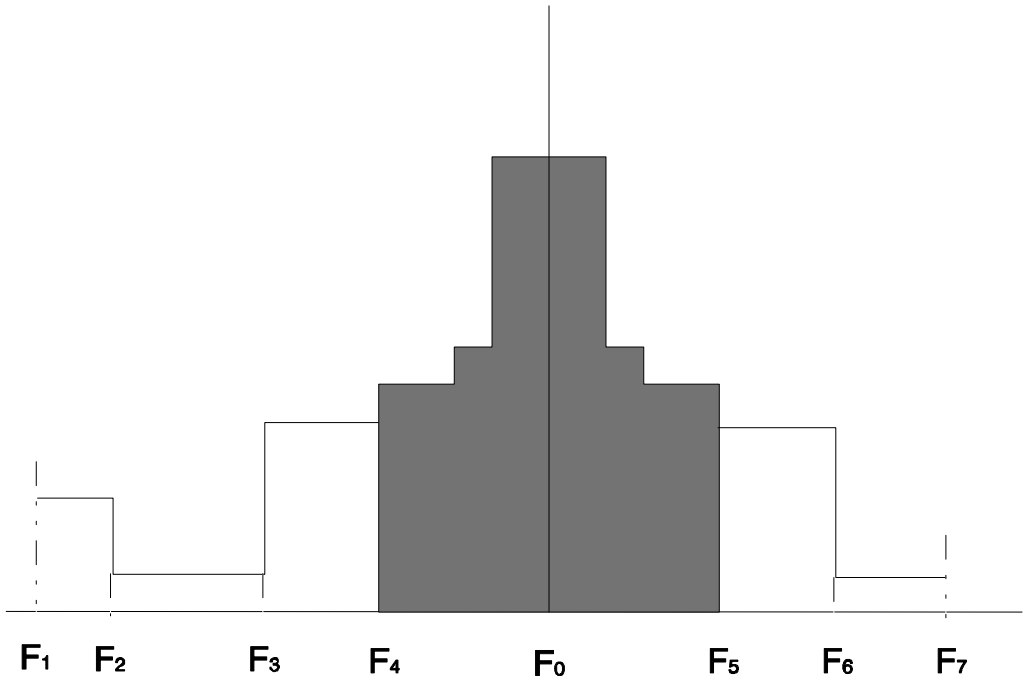


Figure 4: Spurious emission mask

Table 5: Frequency breakpoints for spurious emissions limits

F_1	30 MHz
F_2	1 GHz
F_3	F_0 -250 % Channel spacing -56 MHz or -450 % channel spacing whichever is less stringent
F_4	F_0 -250 % channel spacing
F_5	F_0 +250 % channel spacing
F_6	F_0 +250 % Channel spacing +56 MHz or +450 % channel spacing whichever is less stringent
F_7	$5 \times F_0$

5.6 Receiver characteristics

5.6.1 Receiver (Rx) LO frequency arrangements

There is no requirement on LO frequency arrangement.

5.6.2 Spurious emissions

The limits for receiver spurious emissions referenced at point C of figure 2 are shown in table 6.

Table 6: Receiver spurious emissions allowed for CRS, RS and TS.

$30 < f < (5 \times F_0)$	-50 dBm (see note) for CRS and RS without TE interfaces
	-40 dBm (see note) for RS with TE interfaces and TS
NOTE: Spurious emissions to be measured in a 1 MHz resolution bandwidth for emissions above 1 GHz and in a 100 kHz resolution bandwidth for emissions falling between 30 MHz and 1 GHz.	

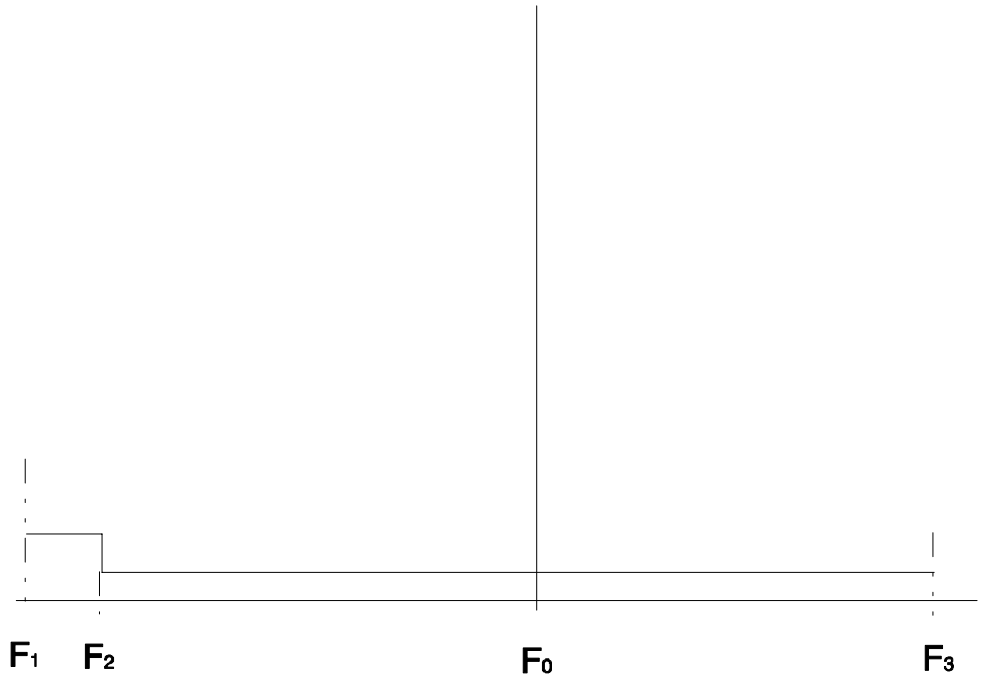


Figure 5: Spurious emission mask

Table 7: Frequency breakpoints for spurious emissions limits

F_1	30 MHz
F_2	1 GHz
F_3	$5 \times F_0$

5.7 System performance without diversity

The parameters stated below shall be met under any load condition.

5.7.1 Dynamic level range

The dynamic level range shall exceed 50 dB. The exact value shall be declared by the manufacturer. Within the dynamic level range the BER shall be lower than 10^{-3}.

5.7.2 BER as a function of Receiver input Signal Level (RSL)

For Class A systems, each FDMA receiver input signal level at the BER thresholds (dBm) referred to point C (see figure 2) for BER of 10^{-3} and 10^{-6} shall be equal to or lower than those stated in table 8. For bit rates of 2 Mbit/s as a reference, taking into account forward error correction for the different modulation schemes.

The BER performance shall be measured from the CRS to the TS (outbound) and from the TS to the CRS (inbound).

Table 8: BER performance thresholds for different modulation schemes (Class A) for 2 Mbit/s

	RSL/dBm for BER ≤ 10^{-3}			**RSL /dBm for BER ≤ 10^{-6}**		
Frequency band (GHz)	**Modulation states**			**Modulation states**		
----	4	8	16	4	8	16
3,5	-100	-99	-94	-97,5	-96,5	-91,5
10,5	-100	-99	-94	-97,5	-96,5	-91,5

Applying other bit rates, the relevant receive levels may be calculated according to the following formulas:

- 4-state modulation schemes (or equivalent) (Class A):
  - P_e= -103 + 10*$\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-3};
  - P_e= -100,5 + 10*$\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-6}.
- 8-state modulation schemes (or equivalent) (Class A):
  - P_e= -102 + 10*$\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-3};
  - P_e= -99,5 + 10*$\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-6}.
- 16-state modulation schemes (or equivalent) (Class A):
  - P_e= -97 + 10*$\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-3};
  - P_e= -94,5 + 10*$\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-6}.

For Class B systems, each FDMA receiver input signal level at the BER thresholds (dBm) referred to point C (see figure 2) for BER of 10^{-3}, and 10^{-6} shall be equal to or lower than those stated in table 9. For bit rates of 2 Mbit/s as a reference, the BER performance should be measured from the CRS (transceiver) to the TS (Outbound) and from the TS to the CRS (Inbound).

Table 9: BER performance thresholds for different modulation schemes (Class B) for 2 Mbit/s

RSL	RSL/dBm for BER ≤ 10^{-3}			RSL /dBm for BER ≤ 10^{-6}		
Frequency band /GHz	Modulation states			Modulation states		
----	4	8	16	4	8	16
3,5	-90	-87	-84	-86	-83	-79
10,5	-90	-87	-84	-86	-83	-79

Applying other bit rates the relevant receive levels may be calculated according the following formulas:

- 4-state modulation schemes (Class B):
  - P_e= -93 + 10 × $\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-3};
  - P_e= -89 + 10 × $\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-6}.
- 8-state modulation schemes (Class B):
  - P_e= -90 + 10 × $\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-3};
  - P_e= -86 + 10 × $\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-6}.
- 16-state modulation schemes (Class B):
  - P_e= -87 + 10 × $\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-3};
  - P_e= -82 + 10 × $\log_{10}$ (bit rate/Mbit/s) [dBm] for BER 10^{-6}.

5.7.3 Equipment Background BER (BBER)

Following ITU-T Recommendations G.821 [5] and/or G.826 [5] the equipment BBER under simulated operating conditions is measured with a signal level at reference point C (figure 2) which is 6 dB above the specified level for BER = 10^{-6} in subclause 5.7.2 taking into account the actual test load conditions. For different payload bit rates the measurement time and the maximum number of errors allowed are given in table 10.

Table 10: Maximum number of errors allowed, measuring the equipment BBER

Payload bit rate (kbit/s)	Minimum recording time (hours)	Maximum number of errors
≤ 64	20	5
≥ 2 048	15	10

For systems transporting voice band signals the maximum number of errors shall not exceed 10 during a minimum recording time of 24 minutes.

5.7.4 Interference sensitivity (external)

5.7.4.1 Co-channel interference

The limits of co-channel interference (external) for Class A systems shall be as in table 11, giving maximum Signal to Interference (S/I) values for 1 dB and 3 dB degradation of the 10^{-3} and 10^{-6} BER limits specified in subclause 5.7.2.

Table 11: Co-channel interference sensitivity for Class A systems

Description	BER			
	10^{-3}		10^{-6}	
Threshold degradation	1 dB	3 dB	1 dB	3 dB
Signal to Interference level	S/I (dB)	S/I (dB)	S/I (dB)	S/I (dB)
4 state modulation	15	11,5	17,5	13,5
8 state modulation	16	12,5	19,5	15,5
16 state modulation	23	19,5	26,5	22,5

For Class B systems, the S/I values stated in table 11 are allowed to be 5 dB higher.

5.7.4.2 Adjacent channel interference

The limits of adjacent channel interference (external) for Class A systems shall be as given in table 12 for like modulated signals, giving maximum S/I values for 1 dB and 3 dB degradation of the 10^{-3} and 10^{-6} BER limits specified in subclause 5.7.2.

Table 12: Adjacent channel interference sensitivity

Description	BER			
	10^{-3}		10^{-6}	
Threshold degradation	1 dB	3 dB	1 dB	3 dB
Signal to Interference level	S/I (dB)	S/I (dB)	S/I (dB)	S/I (dB)
4 state modulation	-18	-21,5	-15,5	-19,5
8 state modulation	-17	-20,5	-13,5	-17,5
16 state modulation	-10	-13,5	- 6,5	-10,5

For Class B systems, the S/I values stated in table 12 are allowed to be 5 dB higher.

5.7.5 Distortion sensitivity

Distortion sensitivity due to multipath fading is not considered in the present document.

5.7.6 Continuous Wave (CW) spurious interference

The immunity of the receiver(s) to CW spurious interference is defined in DE/TM-04040 [29]. This test is designed to identify specific frequencies at which the receiver may have a spurious response; e.g. image frequency, harmonics of the

receive filter, etc. The actual test range should be adjusted accordingly. The test is not intended to imply a relaxed specification at all out of band frequencies elsewhere specified in the present document.

For a receiver operating at the 10^{-6} BER threshold given in tables 8 and 9 respectively, the introduction of a CW interferer at a level of +30 dB, with respect to the "wanted" signal at any frequency in the range 1 GHz to 40 GHz, excluding frequencies on either side of the "wanted frequency" (RF-channel spacing) till up to 450 % the co-polar channel spacing, shall not result in a BER greater than 10^{-5}.

5.8 System performance with diversity

Diversity operation is not considered in the present document.

6 Types of interfaces at the subscriber equipment and the network node

Table 13 lists a range of interfaces for various voice and data services. At least one of these interfaces shall be implemented in a P-MP system covered by the present document.

Table 13: Types of interfaces/ranges

Interface	Proposed Standards
Subscriber equipment interfaces	
Analogue (2 wires)	ITU-T Recommendation Q.552 [30]
Analogue (4 wire plus E & M)	ITU-T Recommendation Q.553 [31]
Telex	ITU-T Recommendation R.20 [32] and V.series [33]
Digital data port (electrical)	ITU-T Recommendation G.703 [20], X.series [34] and V series [33]
ISDN basic rate (U and S interfaces)	ITU -T Recommendation G.961 [35]; ETS 300 012 [36]
ISDN primary rate (U and S interfaces)	ITU-T Recommendation G.962 [38]; ETS 300 011 [37]
SDH interfaces	ITU-T Recommendation G.707 [39]
Network interfaces	
2 Mbit/s	ITU-T Recommendation G.703 [20]
Analogue (2 wires)	ITU-T Recommendation Q. 552 [30]
Analogue (4 wire plus E & M)	ITU-T Recommendation Q. 553 [31]
Telex	ITU-T Recommendation R.20 [32] and V.Series [33]
Digital data port (electrical)	ITU-T Recommendation G.703 [20], X.series [34] and V series [33]
Digital data port (optical)	ITU-T Recommendation G. 957 [42]
ISDN + analogue subscribers + leased lines 2 Mbit/s interface	ITU-T Recommendation G.703 [20] ITU-T Recommendation G.964 [40], V5.1 ITU-T Recommendation G.965 [41], V5.2 ETS 300 324 [43] ETS 300 347 [44]
ISDN U interface	ITU-T Recommendation G.961 [35]
SDH interfaces	ITU-T Recommendations G.703 [20] G.707 [39], G.957 [42]

NOTE: Further interfaces may be implemented.

History

Document history				
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